US Army Corps of Engineers
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Zebra Mussel Research Technical Notes

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Use of Microorganisms and Their Metabolites for Zebra Mussel Control

Background and purpose

The control of zebra mussel fouling has largely involved chemical and/or physical measures, many of which are expensive and environmentally unacceptable. Chlorination and other biocides are often used to eradicate mussel fouling. Intensive posttreatment cleaning is also used, because of the strong attachment of zebra mussel byssal threads to surfaces. Novel methods of control which are environmentally acceptable are needed. Biological control, which has not been extensively explored, may yield innovative control strategies.

This technical note describes a biological approach to the problem of controlling zebra mussel fouling which is based on the use of naturally occurring bacteria as control agents. The purpose of this research is to develop novel, environmentally acceptable antifouling agents, based on the use of metabolites produced by specific natural microorganisms isolated from the aquatic environment.

Additional information

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Experimental approach

For the experiments described in this technical note, young zebra mussels were obtained from Lake Ontario and the New York Finger Lakes. They were maintained in artificial lake water and survived well for many months. All of the studies were carried out at ambient temperatures in the laboratory. Bacteria for these investigations were isolated from both lake water and zebra mussels. Lethality experiments were carried out using healthy zebra mussels. Death of mussels was assessed over 5 days in petri dishes in the presence of either the bacterial isolates or their metabolites.

Tests to determine the effects of bacterial metabolites or natural products as repellants to prevent attachment of zebra mussels to surfaces were undertaken by incorporating the biological chemicals

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in polymeric coatings and challenging the coatings with juvenile zebra mussels. Repulsion of zebra mussels by living bacteria was also analyzed using biofilms of bacteria on surfaces.

Results

Within 5 days, it was possible to isolate and obtain in pure culture a large library of bacteria capable of killing juvenile zebra mussels. These bacteria were usually isolated from mussels stressed by either starvation or increased temperature. The isolates belong mainly to the bacterial genus *Pseudomonas*.

For a number of the most antagonistic bacteria, culture filtrates were examined for their effects on mussels. It was determined that all of the cell-free extracts were lethal for the mussels. The antagonistic factors had a molecular size larger than 10,000 Daltons. The predominant active fractions were proteins and polysaccharides. Chemical analysis indicated that the lethal factors are polar compounds. Work continues to fractionate and analyze these bacterial products in order to identify the most important lethal agents against zebra mussels.

Another area of study involves the ability of nonlethal bacteria to repel zebra mussels from surfaces. It has been possible to isolate a number of bacteria which, when attached in biofilms to surfaces, prevent the adhesion of mussels. Further research will test the capacity of the metabolites of these bacteria to act as zebra mussel repellants and will focus on separating and identifying the active repellant agents.

In another phase of this research, nontoxic, environmentally acceptable natural products are being screened for their ability to repel zebra mussels (Gu, Maki, and Mitchell 1997). A very wide range of chemicals have been tested for their ability to prevent zebra mussel attachment to surfaces. Among these chemicals are quinones, which are known to be active against marine fouling organisms. The initial data suggest that some quinones are strong repellants for zebra mussels and can protect surfaces against fouling. This research will focus on the predominant chemicals that might be used as targeted antifoulants, specific for zebra mussels without damaging other aquatic species.

Implications for control

Research results indicate that it is possible to use microbial metabolites as natural, biodegradable lethal agents for zebra mussel control. Nonlethal repellants, either produced by bacteria or obtained from other nonmicrobial natural sources, may be used to prevent zebra mussel fouling.

Reference

Gu, J. D., Maki, J. S., and Mitchell, R. (1997). "Microbial biofilms and their role in the induction and inhibition of invertebrate settlement." *Zebra mussels and other aquatic nuisance species*. F. D'Itri, ed., Ann Arbor Press, Ann Arbor, MI.